RESIDUAL FLUORIDE IN FOOD FUMIGATED WITH SULFURYL FLUORIDE

SUMMARY: New US federal allowances for inorganic fluoride residues in food fumigated with sulfuryl fluoride are excessively high and are at levels known to cause serious adverse health effects, including crippling skeletal fluorosis.

Fluoride in food has long been recognized as a potential source of adverse health effects including dental fluorosis, bone and joint defects, gastrointestinal disturbances, and muscular-neurological disorders,[1-2] plus even crippling skeletal fluorosis.[3] In China, food contaminated by fluoride (F) from unvented coal burning used to dry and preserve grains and other crops is an important source of F intake,[4] and F levels from such exposure ranging from 18 to 87 ppm in corn and 114 to 1109 ppm in chili have been reported.[5] In these coal-burning F-endemic areas, even with very little F in the drinking water, the total daily F intake by affected adults has been estimated to be between 6.12 and 9.65 mg, with the major contribution coming from food.[5] By contrast, in non-endemic areas, daily F intake was estimated to be only 0.8 mg/day.[5] Therefore, any appreciable increase in F intake resulting from commercial food fumigation procedures can only be viewed with grave concern.

In place of methyl bromide as an insecticide fumigant because of its upper atmosphere ozone depleting ability, a number of substitutes are already in use with varying results. For example, various combinations of phosphine (PH_3) and carbon dioxide have been fairly successful for food as well as general fumigation, although equipment corrosion from phosphine and insect resistance to it are among its drawbacks.

Ideally, a fumigant should penetrate quickly into porous materials, be effective against a wide variety of insects and other pests, cause no undesirable changes or odors in the material treated, and dissipate rapidly during removal by aeration. With these criteria in mind, Dow Chemical in the late 1950s developed sulfuryl fluoride (SO_2F_2) as a structure fumigant for enclosed spaces and marketed it in 1961 under the trade name Vikane™ as a non-corrosive, highly penetrating gas (bp –55°C) that is stable in air and less soluble in water than methyl bromide. Unlike methyl bromide, SO_2F_2 does not deplete the upper ozone layer when released into the atmosphere. These and other desirable properties, plus its marked toxicity to all types of insect pests, have made Vikane™ a recommended fumigant for a wide variety of closed structures, furnishings, and non-food materials. Mechanistically, it exerts its toxic action within the cells of insects and other pests by disrupting glycolysis and other critical metabolic processes.

Depending on its application, however, there is a major downside for the use of Vikane™ as a fumigant. Although aeration dissipates it almost completely, it can and does leave considerable amounts of F anion as a break-down product in the material that has been fumigated with it. For this reason and evidently in view of the toxicity of F in food cited above, Dow Chemical and the US Environmental Protection Agency, at least until the mid-1990s, had guidelines which emphasized: “Under no circumstances should Vikane™ be used on raw agricultural food commodities, foods, feeds, or medicinal products destined for human or animal consumption, or on living plants.”[6]

Nevertheless, Dow AgroSciences, a separate division of Dow Chemical, recently disregarded these restrictions and offered sulfuryl fluoride under a new trade name, ProFume™ gas fumigant, as “a solution to the methyl bromide phase out for post-harvest fumigations such as mills, warehouses, grain storage, and transportation vehicles.” Then, in January 2004, as noted in a report by Ellen and Paul Connett to be presented at the XXVIth ISFR conference September 26-29 in Wiesbaden, Germany (Abstract No. 8 in this issue of *Fluoride*, p. 225-6), the US EPA did a complete about face and approved ProFume™ fumigation for over 40 post-harvest food commodities for human consumption that, according to data submitted by Dow AgroSciences, could leave inorganic fluoride (F^-) residues as high as 130 ppm in wheat germ, 125 ppm in wheat flour, and 75 ppm in rolled oats and oat flour.

In March 2005 Dow AgroSciences petitioned EPA for new F tolerances for over 600 commodities, including an unprecedented 3 ppm in powdered milk, 12 ppm in coffee, 70 ppm in many processed foods, 40 ppm in beef meat, and an extraordinary 850 ppm in dried eggs. On July 15, 2005, the EPA issued a “Final Rule” approving and even increasing many of these requests, e.g., 5 ppm in powdered milk, 15 ppm in coffee, 70 ppm in virtually *all* processed foods, and 900 ppm in dried eggs. Many of these levels are more than ten times higher than ever approved previously and, as noted at the beginning of these comments, can result in daily F intake levels from ProFume™ fumigated foods that are clearly in the toxic range. In support of its action, the EPA cited the 1997 report of the Institute of Medicine of the US National Academy of Sciences, which ignored data cited above, and proposed a “tolerable” F intake of 10 mg/day for adults and children 8 years and older. At this level of intake, crippling skeletal fluorosis is an end-stage of F intoxication; it is usually preceded and accompanied by severe dental fluorosis and a wide range of neurological, muscular, gastrointestinal, and other debilitating toxic effects.[1-5]

Fortunately, usually only part of all marketed food is likely to be fumigated with sulfuryl fluoride, and the amount of F that is absorbed and biologically available from food is generally less than that absorbed from the same amount of F in water and beverages. Even so, as already indicated, serious intoxication from F in food can be a very real hazard that appears to have been completely overlooked in these new requests and approvals for F tolerances in food that are many times higher than ever allowed in the past. One can only wonder why Dow AgroSciences and the EPA would risk discounting and denying massive amounts of scientific evidence that refutes claims for the safety of these new tolerances. How such an ill-considered point of view could arise can only be conjectured. The absence of any discussion of sulfuryl fluoride as a fumigant in most texts on environmental fluoride and toxicology might help explain it. In any event, it certainly appears that “misplaced trust in official reports”[7] has replaced thorough independent investigation and evaluation of all available evidence concerning F residues that are being allowed from the use of sulfuryl fluoride for food fumigation.

Over the years, tolerances for food and water contaminants like arsenic and lead have been lowered, not raised. In the case of fluoride, the opposite has occurred on grounds that are more than questionable. Responsible science is built on the secure foundations of sound knowledge and evidence from research, not wishful thinking. Never to be forgotten is the fact that oftentimes painful lessons of the past cannot be ignored with impunity.

Albert W. Burgstahler, PhD
Editor

REFERENCES

1 Roholm K. Fluorine Intoxication: a clinical hygienic study with a review of the literature and some experimental investigations. Copenhagen: NYT Nordisk Forlag; London: HK Lewis; 1937; p. 308-9.

2 Waldbott GL, Burgstahler AW, McKinney HL. Fluoridation: The Great Dilemma. Lawrence, KS: Coronado Press. 1978; p. 36-40, 128-130, 140-141, and 355-356.

3 Huo D. X-Ray analysis of 34 cases of foodborne skeletal fluorosis. Fluoride 1981;14:51-5. Cf. Editorial: Food-induced skeletal fluorosis. Fluoride 1981;14:49-50.

4 Hiu P. The control of coal-burning fluorosis in China. Fluoride 1997;30:229-32.

5 Zhang Y and Cao SR. Coal burning induced endemic fluorosis in China. Fluoride 1996;29:207-11.

6 Quoted in U.S. EPA Methyl Bromide Alternative Case Study Part of EPA 430-R-96-021, Case Studies, Volume 2, December 1996. Available on http://mbao.org/sulfury2.html

7 Krook LP, Connett P, Burgstahler AW. Misplaced trust in official reports [Book review editorial]. Fluoride 2003;37:147-50.

Published by the International Society for Fluoride Research
http://homepages.ihug.co.nz/~spittle/fluoride-journal.htm
Editorial Office: 727 Brighton Road, Ocean View, Dunedin 9051, New Zealand